

Bull. Natn. Sci. Mus., Ser. A (Zool.), 6 (3), September 22, 1980

A New Species of *Rhinolophus* (Chiroptera, Rhinolophidae) from
Iriomote Island, Ryukyu Islands, with Notes on the Asiatic
Members of the *Rhinolophus pusillus* Group

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Of the several Asian species of small *Rhinolophus* whose noseleaves have a triangular or pointed connecting process, only *R. cornutus* TEMMINCK, 1834 has been reported hitherto from Japan and the Ryukyu Islands. The nominate subspecies occurs in Japan and on some nearby islands, with several closely associated subspecies on the more distant islands of the Ryukyu chain: *R. c. orii* KURODA, 1924 from Tokunoshima, *R. c. pumilus* ANDERSEN, 1905 from Okinawa, *R. c. miyakonis* KURODA, 1924 from Miyako-jima and *R. c. perditus* ANDERSEN, 1918 from Ishigaki-jima. Specimens obtained in 1968 and in 1972 on Iriomote Island, in the southern Ryukyu Islands about 20 km west of Ishigaki-jima, however, cannot be referred to *R. cornutus* from which they differ in a number of features. Instead they apparently represent an undescribed species closely allied to *R. cognatus* ANDERSEN, 1906 from the Andaman Islands and to *R. monoceros* ANDERSEN, 1905 from Taiwan. *Rhinolophus cornutus perditus* has been recorded from Iriomote Island by KURODA (1938, p. 67) and by IMAIZUMI (1967, p. 75) but it is possible that these records refer instead to the new species.

Iriomote Island is one of the Yayeyama group lying about 200 km east of Taiwan. It is a small island of a little less than 300 km² in area and some 470 m at its highest point: much is highland above 100 m, with dense subtropical forest. Among bats *Pteropus dasymallus yayeyamae* KURODA, 1933, *Hipposideros turpis turpis* BANGS, 1901, and *Miniopterus schreibersii blepotis* (TEMMINCK, 1840) (of which *M. s. yayeyamae* KURODA, 1924 is usually considered a synonym) have been recorded from the island. Its fauna also includes an endemic cat, *Mayailurus iriomotensis* IMAIZUMI, 1967 and a pig, *Sus scrofa riukiuanus* KURODA, 1924.

The specimens used for the present study are deposited at the Department of Zoology, National Science Museum, Tokyo (NSMT-M) and the Department of Zoology, British Museum (Natural History), London (BM(NH)).

Rhinolophus imaizumii sp. nov.

[Japanese name: Iriomote-kikugashirakômorî]

Holotype. Adult ♂ NSMT-M21231. Ôtomi-dô Cave, Iriomote Island, Yaya-yama Islands, south Ryukyu Islands. Collected 19 March 1968, by Kunihiro TSUDA. In alcohol, skull extracted.

Paratype. Adult ♂ BM(NH) 80.465. As holotype.

Other specimens. Adult ♀ BM(NH) 80.466. Sumiyoshi-dô Cave, Iriomote Island. Collected 30 November 1972 by Mizuko YOSHIYUKI. Adult ♂ NSMT-M 16444. Takiguchi-dô Cave, Iriomote Island. Collected 4 December 1972, also by Mizuko YOSHIYUKI. Both skins and skulls.

Diagnosis. A member of the *Rhinolophus subbadius* subgroup of TATE and ARCHBOLD (1939, p. 3) (the *R. garoensis* subgroup of ANDERSEN, 1918, p. 376) similar in most respects to *R. cognatus* from the Andaman Islands; differs from *R. c. cognatus* from South Andaman Island in narrower rostrum with less inflated median anterior narial swellings and shorter but heavier and more massive upper canines; from *R. c. famulus* ANDERSEN, 1918 from North Central Andaman Island in greater size, slightly smaller median anterior narial swellings and generally heavier dentition; differs from both in slightly narrower post-palatal emargination; similar also to *R. monoceros* from Taiwan or to *R. subbadius* BLYTH, 1844 from the southeast Asian mainland, but larger, the lancet with a more or less spatulate tip rather than subtriangular in outline as it is in these species, and with heavier skull and dentition.

Description. A small species (length of forearm 40–43 mm); noseleaf broad, completely covering muzzle; edge of anterior part of leaf medianly emarginated, a small, tooth-like lateral projection at each edge of notch; sella broad basally, at its centre almost as wide as basal part between nostrils, its centre section with parallel margins, the sella narrowing a little above central region to rounded, anteriorly deflected tip; connecting process a narrow, slender, anteriorly projecting horn, its anterior margin concave in profile, its posterior margin convex, the process sparsely haired; lancet with slightly concave lateral margins and narrow, more or less spatulate terminal part with rounded tip. Ear large, its anterior margin strongly convex, the tip bluntly pointed, the posterior margin slightly concave just beneath tip, otherwise convex, with prominent rhomboid antitragal lobe, separated posteriorly by a deep, acute notch, upper margin of lobe sloping anteriorly. Colour of holotype and paratype affected by wet preservation but dorsal surface now bright brown, the hairs basally creamy, the ventral surface paler; dry specimens from Sumiyoshi-dô and Takiguchi-dô Caves are brown dorsally, the hairs pale brown at the base and for much of their length, tipped with darker, brighter brown, the paler under colour showing through the darker tipping; ventral surface lighter, the hairs similarly pale brown or creamy

Figs. 1–2. *Rhinolophus imaizumii* sp. nov., adult female, BM(NH) 80.466, from Sumiyoshi-dô Cave, Iriomote Island. — 1. Connecting process of noseleaf, lateral aspect. — 2. Head, lateral aspect.

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for much or all of their length, lacking dark tips on chin, throat and median part of chest, on flanks and abdomen tipped with darker brown.

Skull strong, with large, elongate braincase and low sagittal crest; rostrum relatively short and wide, posteriorly with low supraorbital ridges enclosing a shallow supraorbital depression; median anterior narial swellings low, only moderately inflated; zygoma strong and deep; palatal bridge short, less than one-third length of maxillary toothrow, anteriorly terminating on a line joining posterior faces of the second upper premolars (pm^{4-4}), the posterior palatal emargination extending almost to a line joining the centres of the second upper molars (m^{2-2}), narrower or equal in width to anterior palatal emargination (posterior emargination wider than anterior emargination in *Rhinolophus cognatus*, the emarginations subequal in width in *R. monoceros* and *R. subbadius*); bullae not closely adpressed.

Upper incisor (i^3) very small, bicuspid; upper canine short, strong and massive, with knife-like posterior cutting edge; anterior upper premolar (pm^2) small, with definite, pointed, inwardly directed cusp, in toothrow, in contact with canine and with second upper premolar (pm^4); lower incisors (i_{1-2}) small, tricuspid, not markedly imbricated; lower canine slender; second lower premolar (pm_3) small, intruded from toothrow; molars without especial features.

Measurements of *Rhinolophus imaizumii*, *R. cognatus*, *R. monoceros* and *R. subbadius* appear in Tables 1 and 2.

Etymology. The new species is named after Dr. Yoshinori IMAIZUMI of the Department of Zoology, National Science Museum, Tokyo, in recognition of his contribution to mammalogy in Japan.

Remarks. ANDERSEN (1905 a, b, 1918) attempted the first detailed clarification of the taxonomy of the small *Rhinolophus* (the *pusillus* group) of eastern and southeastern Asia that have a more or less triangular or pointed connecting process. Unfortunately the last of these papers is incomplete, having been issued by Oldfield THOMAS on behalf of ANDERSEN after his untimely disappearance towards the end of the First World War, consisting entirely of keys in which new taxa are briefly diagnosed. TATE and ARCHBOLD (1939) subsequently summarised the synoptic arrangements proposed by ANDERSEN with the addition of more recently described forms. Since then no overall review of the group has appeared although some of its members have been examined in detail by authors of chiefly faunal works such as ALLEN (1938), HILL (1974) or LEKAGUL and MCNEELY (1977).

The group as recognised by ANDERSEN (1905 b, p. 650, as the *Rhinolophus lepidus* group) includes a number of species such as *R. blasii* and *R. euryale* from the western Palearctic and *R. landeri* from Africa (see below) besides those from eastern and southeastern Asia. ANDERSEN (1905 a, p. 122) recognised three subdivisions among the Asiatic forms, namely the *lepidus*, *minor* (= *pusillus*) and *subbadius* sections. Later, this author (1918, p. 376) renamed the assemblage the *pusillus* group (by far the earliest name) with *pusillus*, *acuminatus* and *garoensis* (= *subbadius*) subgroups, by inference also considering *lepidus* and its allies as a further subgroup. For the most part TATE

Table 1. Lengths (in millimetres) of external elements of *Rhinolophus imaizumii*, *R. cognatus*, *R. monoceros* and *R. subbadius*.

	<i>R. imaizumii</i>			<i>R. cognatus</i>			<i>R. monoceros</i>		<i>R. subbadius</i>	
	♂ NSMT-M 21231 Holotype	Number of specimens	Range	<i>R. c. cognatus</i> ♂ BM(NH) 6.12.1.12 “Cotype”	<i>R. c. famulus</i> ♀ BM(NH) 9.4.4.8 Holotype	<i>R. c. famulus</i> ♀ BM(NH) 9.4.4.7	Number of specimens	Range	Number of specimens	Range
Forearm	42.8	4	40.1– 42.8	39.2	39.6	39.7	16	34– 38.5	6	34.1– 35.9
III ^m	32.5	4	31.1– 32.5	30.4	29.4	29.3	11	25– 29.6	7	24.8– 27.3
III ¹	12.3	4	12.1– 12.4	11.6	11.5	12.2	1	11.6	7	9.4– 10.3
III ²	18.9	4	17.7– 18.9	18.3	17.1	17.1	1	17.3	7	12.5– 15.3
IV ^m	33.1	4	31.1– 33.1	31.0	30.3	30.7	11	26– 30.3	7	25.8– 28.9
IV ¹	9.8	4	9.7– 10.3	8.4	8.2	8.5	1	8.9	7	7.2– 8.1
IV ²	11.7	4	10.4– 11.7	11.4	10.5	11.4	1	10.5	7	8.2– 9.7
V ^m	32.4	4	31.0– 32.6	30.9	29.4	29.8	11	26– 30.2	7	25.7– 28.4
V ¹	10.4	4	10.3– 10.8	9.0	9.0	9.3	1	9.9	7	7.5– 8.8
V ²	11.4	4	11.0– 11.6	12.0	11.5	11.8	1	11.1	7	8.2– 10.6
Tibia	17.8	4	17.5– 17.8	17.1	16.3	16.4	16	13.5– 17.0	7	13.6– 15.6

Measurements of *R. monoceros* taken chiefly from ÅRNBÄCK-CHRISTIE-LINDE (1908, p. 237), KURODA (1935, p. 289, 1940, p. 210) and MORII (1975, p. 123).

and ARCHBOLD (1939, p. 3) followed the arrangement proposed by ANDERSEN but did not recognise the *acuminatus* subgroup and referred *cognatus* and *famulus* from the Andaman Islands to the *lepidus* subgroup (perhaps influenced by ANDERSEN (1906 b, p. 182) who suggested an alliance between *cognatus* and the mainland *refulgens*) rather than to the *garoensis* (= *subbadius*) subgroup where ANDERSEN (1918, p. 377) had clearly placed both Andamanese forms.

The collections of the British Museum (Natural History) suggest that provisionally eight species (including *Rhinolophus imaizumii*) of the group can be recognised in eastern and southeastern Asia. Some are as yet very poorly represented and the

Table 2. Cranial measurements (in millimetres) of *Rhinolophus imaizumii*, *R. cognatus*, *R. monoceros* and *R. subbadius*.

	<i>R. imaizumii</i>			<i>R. cognatus</i>			<i>R. monoceros</i>			<i>R. subbadius</i>	
	♂ NSMT-M 21231 Holotype	Number of specimens	Range	<i>R. c. cognatus</i> ♂ BM(NH) 6.12.1.12 “Cotype”	<i>R. c. famulus</i> ♀ BM(NH) 9.4.4.8 Holotype	<i>R. c. famulus</i> ♀ BM(NH) 9.4.4.7	Number of specimens	Range	Number of specimens	Range	
Greatest length of skull	18.3	3	18.0–18.4	18.6	—	17.2	9	14.4–15.5	—	—	
Condylobasal length	16.2	3	16.0–16.3	16.6	—	15.5	—	—	2	13.4	
Condyl canine length	15.6	4	15.1–15.7	15.9	14.4	15.0	1	ca. 12.5	4	11.9–13.0	
Width of rostrum	4.6	4	4.5–4.6	4.9	4.4	4.6	1	4.0	6	3.4–3.6	
Least interorbital width	2.0	4	2.0–2.2	2.3	2.2	2.3	3	2.0–2.5	2	1.9–2.0	
Zygomatic width	8.5	3	8.5–8.6	8.6	8.5	8.6	9	6.6–7.5	—	—	
Width of braincase	7.3	4	7.1–7.3	7.4	6.9	7.1	9	6.8–7.3	3	6.0–7.2	
Mastoid width	8.3	4	8.2–8.3	8.4	7.9	8.0	2	7.1–7.4	3	7.1–7.4	
Palatal length	2.1	4	2.0–2.1	2.1	—	—	—	—	4	1.3–1.5	
c ¹ –c ¹	4.6	4	4.5–4.6	4.7	4.1	4.1	1	3.6	4	2.9–3.2	
m ³ –m ³	6.4	4	6.2–6.4	6.4	5.8	6.0	1	5.4	3	4.8–4.9	
c–m ³	6.8	4	6.4–6.8	6.9	6.1	6.4	10	5.4–5.7	6	5.1–5.4	
Length of complete mandible	11.4	2	11.2–11.4	11.7	10.5	10.9	1	9.7	—	—	
Length of right ramus	11.7	4	11.4–11.8	12.0	10.8	11.4	1	10.1	3	9.1–9.2	
c–m ₃	7.3	3	7.2–7.3	7.4	6.7	7.0	10	5.5–6.0	6	5.4–5.6	

Measurements of *R. monoceros* taken chiefly from KURODA (1935, p. 289, 1940, p. 210).

collections lack material from areas critical to the taxonomy of others so that to this extent any classification must remain uncertain. They may be keyed (measurements in millimetres):

1. Connecting process triangular in profile 2
- Connecting process an erect, narrow horn 5
2. Larger, forearm 46–53.....*acuminatus*
- Smaller, forearm 31–42..... 3
3. Skull larger, condylocanine length 14.2–16.4, c-m³ 6.0–7.1, rostrum wide, its width 4.4–5.0, median rostral swellings slightly elevated, rostral profile curving upwards near tip, slightly concave behind swellings.....*lepidus*
- Skull smaller, condylocanine length 13.2–14.6, c-m³ 5.4–6.2, rostrum narrow, its width 3.8–4.5, median rostral swellings not elevated, rostral profile nearly straight, almost horizontal..... 4
4. Connecting process broadly based, its lower part fully occupying space between sella and lancet.....*pusillus*
- Connecting process slightly narrowed basally, its lower part not completely occupying space between sella and lancet.....*cornutus*
5. Lateral margins of lancet straight or nearly so, the lancet triangular with rounded tip..... 6
- Lateral margins of lancet slightly concave, its upper part more or less spatulate 7
6. Smaller, forearm 31.5–34.5, c-m³ 5.1–5.4*subbadius*
- Larger, forearm 34–38.5, c-m³ 5.4–5.7*monoceros*
7. Median anterior narial swellings moderately inflated, posterior palatal emargination wider than anterior palatal emargination, upper canines relatively slender*cognatus*
- Median anterior narial swellings low, only slightly inflated, posterior palatal emargination narrower than anterior palatal emargination or equal to it in width, upper canines relatively massive.....*imaizumii*

***Rhinolophus acuminatus* PETERS, 1871**

A medium-sized species; wide median emargination of anterior leaf succeeded by a shallow triangular groove; central part of sella expanded, thence parallel-margined or slightly tapered to rounded summit; connecting process triangular with straight anterior margin, blunt point and convex posterior margin; lancet with concave margins, its upper part almost parallel-margined, its tip narrowed, acuminate; ears large, broad. Distributed from southern Thailand to Borneo, Java and Lombok Island; includes as subspecies *sumatranus* ANDERSEN, 1905 (Sumatra); *circe* ANDERSEN, 1906 (Nias Island); *calypso* ANDERSEN, 1905 (Engano Island); *acuminatus* (Java) and *audax* ANDERSEN, 1905 (Lombok Island). Subspecific distinctions are slight and the subspecific identity of the mainland and Bornean populations open to some question (HILL, 1974).

***Rhinolophus lepidus* BLYTH, 1844**

Smaller than *Rhinolophus acuminatus*; median emargination of anterior leaf narrow, lacking any posterior triangular groove; sella narrow and not expanded centrally to any conspicuous extent, its upper part parallel-margined or cuneate to rounded tip; connecting process similar to that of *R. acuminatus*; lancet triangular, high and narrow, with a blunt point; ears moderate. Occurs from Afghanistan through N India to S China, Malaya and Sumatra, including as subspecies *lepidus* (NE India); *monticola* ANDERSEN, 1905 (NW India); *shortridgei* ANDERSEN, 1918 (N Burma); *feae* ANDERSEN, 1905 (S Burma); *refulgens* ANDERSEN, 1905 (S Thailand, Malaya) and *cuneatus* ANDERSEN, 1918 (Sumatra). There seems no reason to retain *refulgens* as a species distinct from *lepidus* which it resembles in every essential particular.

***Rhinolophus pusillus* TEMMINCK, 1834**

A small species; noseleaf wide with small anterior emargination; sella broad basally, slightly constricted centrally, its tip narrow and rounded; connecting process triangular, bluntly pointed, arising just below tip of sella; lancet subtriangular with narrowed tip; ears relatively large. Distributed from N India to S China, Borneo and Java, including as subspecies *blythi* ANDERSEN, 1918 (N India); *gracilis* ANDERSEN, 1905 (Malabar); *szechwanus* ANDERSEN, 1918 (Szechuan); *calidus* G. M. ALLEN, 1923 (Fukien); *parvus* G. M. ALLEN, 1928 (Hainan Island); *minutillus* MILLER, 1906 (Anamba Islands); (?) *pagi* TATE et ARCHBOLD, 1939 (Mentawai Islands) and *pusillus* (Java). *Rhinolophus pagi* seems to belong here although according to its describers the connecting process in two paratypes is curved forwards but in the holotype and three others it is erect; the connecting process of *R. cornutus* sometimes curves in this way.

***Rhinolophus cornutus* TEMMINCK, 1834**

Closely similar to *Rhinolophus pusillus* but connecting process narrower at base, more definitely horn-like, although much less narrowed than in *R. subbadius* and its allies; process varying from subtriangular, its anterior margin straight or even slightly convex, to rather more horn-like and curved, its anterior margin slightly concave. It seems highly probable that *cornutus* and *pusillus* are conspecific and indeed have been considered so by authors such as ELLERMAN and MORRISON-SCOTT (1951, p. 117) and VAN PEENEN, RYAN and LIGHT (1969, p. 61). However, WANG *et al.* (1962, pp. 556, 558, 568) reported *R. cornutus pumilus* and *R. blythi* (as a species) from Kwangsi. *Rhinolophus cornutus* is found in most of Japan, in many of the Ryukyu Islands and possibly in E China; subspecies are *cornutus* (Japan); *pumilus* ANDERSEN, 1905 (Okinawa); *orii* KURODA, 1924 (Tokunoshima); *miyakonis* KURODA, 1924 (Miyako-jima) and *perditus* ANDERSEN, 1918 (Ishigaki-jima).

***Rhinolophus subbadius* BLYTH, 1844**

A very small species with noseleaf and ears similar to those of *Rhinolophus cornutus* or *R. pusillus* but connecting process extending forwards into a slender, sharply pointed horn; lancet low, triangular, with straight margins. There is a tendency for the connecting process to become pointed and to project forwards in *cornutus* but the condition is much less pronounced than in *subbadius* and its allies; a similar tendency occurs apparently in *R. pusillus* (?) *pagi*. TATE and ARCHBOLD (1939, pp. 7, 8) considered *pagi* to link *refulgens* and *cuneatus* (both here referred to *R. lepidus* as subspecies) to *garoensis* (= *subbadius*) and *famulus* (the latter here considered a subspecies of *R. cognatus*), remarking (p. 8) that *pagi* seemed to bridge over the hard and fast division made by ANDERSEN between the *subbadius* and *minor* (= *pusillus*) subgroups. *Rhinolophus subbadius* has been reported from N India, Burma and Vietnam and is a monotypic species; *garoensis* DOBSON, 1872 is a synonym.

***Rhinolophus monoceros* ANDERSEN, 1905**

Closely similar to *Rhinolophus subbadius* but slightly larger; noseleaf almost exactly like that of *subbadius* with similar horn-like connecting process and low, triangular lancet. Unfortunately only two specimens are available in London, the young adult holotype and a second damaged example with fragmentary skull, and the representation of *subbadius* although greater in numbers is also similarly inadequate. Consequently no proper assessment of the relationship of *monoceros* to *subbadius* can be made. As yet the species has been found only on Taiwan, whence ÅRNBÄCK-CHRISTIE-LINDE (1908, p. 237), KURODA (1935, p. 289, 1940, p. 210) and MORII (1975, p. 123) have recorded further specimens.

***Rhinolophus cognatus* ANDERSEN, 1906**

Similar to *Rhinolophus subbadius* and *R. monoceros* but larger with much larger skull; lancet taller, its lateral margins slightly concave, the distal part of the lancet slightly spatulate, with a rounded tip. *Rhinolophus cognatus* is known from few specimens but apparently has two subspecies, *cognatus* (South Andaman Island) and the slightly smaller *famulus* ANDERSEN, 1918 (North Central Andaman Island).

***Rhinolophus imaizumii* HILL et YOSHIYUKI, 1980**

The diagnosis and description of this new species appear above.

Discussion. There is little doubt that *Rhinolophus subbadius*, *R. monoceros*, *R. cognatus* and *R. imaizumii* scarcely justify recognition as a distinct section or subgroup of the *pusillus* group as was done by ANDERSEN (1905 a, 1918), or by TATE and ARCHBOLD (1939). This distinction rests only on the horn-like appearance of the connecting

process, a condition foreshadowed in both *R. cornutus* and *R. pusillus*. Instead, with their Palaearctic counterparts they appear to represent an extreme of the species of the *pusillus* subgroup as listed by these authors. Over the *pusillus* group as a whole Ethiopian and western Palaearctic species parallel those of eastern Asia in the structure of the noseleaf and especially of the connecting process and lancet. In Africa, for example, *alcyone* is similar in many ways to the Asian *acuminatus*, and the *landeri-guineensis* complex to *lepidus*, *pusillus* and *cornutus*, while in the western Palaearctic *euryale*, *mehelyi* and *blasii* correspond to *subbadius* and its allies.

Summary

A new species of *Rhinolophus* from Iriomote Island, Yayeyama Islands, south Ryukyu Islands is diagnosed and described as *R. imaizumii*, closely related to *R. cognatus* from the Andaman Islands. The Asiatic species of the *R. pusillus* group to which it belongs are keyed and briefly discussed, with diagnostic and distributional notes.

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